

# Electromyographic Assessment of Accessory Nerve Function Following Nerve Sparing Neck Dissection

Azeem Mohiyuddin, Sagaya Raj, Shuaib Merchant, Oomen, Philip John Kottaram

## ABSTRACT

**Aims:** To assess preoperative and postoperative shoulder function by electromyography (EMG) in spinal accessory nerve (SAN) sparing neck dissections in head and neck cancers.

**Materials and methods:** A prospective study was done on 50 patients (51 shoulders) with histopathologically proven head and neck cancers with N<sub>0</sub> or N<sub>1</sub> neck who underwent nerve sparing neck dissections. Patients were assessed preoperatively and postoperatively at 3 weeks and 3 months by needle EMG and muscle strength tests of upper trapezius.

**Results and interpretation:** At 3 weeks postoperatively, 11 shoulders (39.3%) in FND group and four shoulders (33.3%) in modified radical neck dissection (MRND) group showed severely abnormal EMG, while in supraomohyoid neck dissection (SOHND) group only two (18.2%) shoulders showed severely abnormal EMG. All patients who underwent nerve sparing neck dissections showed improvement in at least one category on the second electromyogram at 3 months. This could be attributed to neuropraxia or transient devascularization of the accessory nerve. In our study, 11 patients in FND group showed severely abnormal EMG finding, but they did not have as great a degree of shoulder dysfunction as would be expected. This could be due to factors like preoperative condition of other synergistic shoulder girdle muscles, postoperative exercises, etc.

**Conclusion:** SAN injuries are common in all types of nerve sparing neck dissections requiring aggressive physiotherapy for an improved shoulder function. To conclude, in patients in whom it is oncologically sound, nerve sparing neck dissections offers significant benefit in terms of shoulder function.

**Keywords:** Spinal accessory nerve, Electromyography, Supraomohyoid neck dissection.

**How to cite this article:** Mohiyuddin A, Raj S, Merchant S, Oomen, Kottaram PJ. Electromyographic Assessment of Accessory Nerve Function Following Nerve Sparing Neck Dissection. *Int J Head and Neck Surg* 2013;4(1):19-23.

**Source of support:** Nil

**Conflict of interest:** None

## INTRODUCTION

In India, head and neck cancers constitute 46 to 54% of all malignancies.<sup>1</sup> A critical prognostic factor in head and neck cancers is spread of disease to regional lymph nodes and the presence or absence of even microscopic extracapsular spread. A large spectrum of surgical procedures is available to treat the regional lymphatic spread.

Radical neck dissection (RND) required complete removal of lymph nodes from levels I to V, along with the sternocleidomastoid (SCM) muscle, internal jugular vein

(IJV) and spinal accessory nerve (SAN). Functional sequelae of RND are the 'eleventh nerve syndrome' as a result of denervation of trapezius. This may lead to significant restrictions in the patients' professional and social life. Modifications to the RND, like modified radical neck dissection (MRND) and supraomohyoid neck dissection (SOHND) gained more approval, as numerous studies showed that a more conservative approach, sparing the SAN could still control disease and significantly decrease the morbidity in appropriately selected patients.

Although functional superiority of SAN preserving neck dissection is established, any nerve sparing neck dissection can still be associated with some functional disability.

The present study is aimed to compare shoulder function by electromyography (EMG) in different nerve sparing neck dissections.

## MATERIALS AND METHODS

**Aim:** To assess preoperative and postoperative shoulder function by EMG, in SAN sparing neck dissection done for head and neck cancers.

This is a prospective study of 50 head and neck cancer patients without previous surgical interventions who presented at our center, between Nov 2008 and Dec 2009.

### Inclusion Criteria

1. Histopathologically proven head and neck cancers with N<sub>0</sub> or N<sub>1</sub> neck.

### Exclusion Criteria

1. Patients with advanced neck metastasis (N<sub>2</sub>, N<sub>3</sub>).
2. Patients with abnormal EMG preoperatively.
3. Patients with previous ipsilateral neck surgery.
4. Patients undergoing salvage surgery following radiotherapy failure.
5. Neurological disorders.

Patients presenting with clinically N<sub>0</sub> or N<sub>1</sub> neck were taken up for the study and nerve sparing neck dissections were performed (MRND or FND or SOHND) by the same surgeon. In our study, there were seven males and 43 female patients, in the age group ranging from 19 to 80 years (mean age: 50 years).

In 50 patients (Table 1), 51 neck dissections were performed of which 49 were unilateral and one was bilateral. MRND group sacrificing sternomastoid consisted

of 12 shoulders (12 patients), the functional neck dissection group consisted of 28 shoulders (27 patients) and the SOHND group consisted of 11 shoulders (11 patients).

The patients underwent evaluation of shoulder function by trapezius muscle strength test and EMG of upper trapezius (Fig. 1). EMG was done preoperatively, early postoperative period (at 3 weeks) and late postoperative period (at 3 months).

Muscle strength was evaluated by manually testing shoulder abduction. The findings were scored according to the criteria of Daniels and Worthingham's score.<sup>2</sup>

- 5 (Normal): Muscle strength that could be overcome with strong manual resistance.
- 4 (Good): Muscle strength that could be overcome with moderate manual resistance.
- 3 (Fair): Muscle strength sufficient to hold a position against a force of gravity.
- 2 (Poor): Muscle activity only when the upper limb was supported by the examiner.
- 1 (Trace): Only palpable muscle contraction.
- 0 (Zero): No palpable evidence of muscle contraction.

After an informed written consent, electromyographic studies were performed before surgery, during the 3rd week postoperatively and 3rd month postoperatively to assess the effects of these procedures on spinal accessory nerve and the trapezius muscle using needle EMG on upper trapezius (concentric needle electrodes and RMS EP Mark II machine). Recordings were obtained during rest, mild and maximal contraction.

During this procedure the patient sat on a chair with the forearm resting on the patient's thighs and inert. During

the trapezius muscle test, the patient kept the head straight up and was asked to look at a hypothetical point 5° to 10° above the visual horizon. When the subject was completely relaxed electrical silence of both trapezius muscles could be reached. The recording needle was inserted at the angle of neck and shoulder to test upper trapezius.

The electromyograms of the trapezius muscle recorded resting potentials as evidenced by insertional activity, fibrillation potentials-fasciculations and positive sharp waves, as well as active potentials as evidenced by duration, amplitude, phases and recruitment pattern during muscle contraction. Each electromyogram was rated as being normal, slightly abnormal, moderately abnormal or severely abnormal using the classification criteria<sup>3</sup> (Table 2). The muscle strength scores and electromyograms were statistically analyzed using paired t-test and independent t-test.



Fig. 1: Upper trapezius needle EMG in progress

**Table 1: Distribution of cases**

Clinical staging	Buccal mucosa (n = 31)	RMT (n = 1)	Upper alveolus (n = 1)	Lower alveolus (n = 3)	Tongue (n = 3)	Lower lip (n = 1)	Supra-glottis (n = 1)	Sub-glottis (n = 1)	PF (n = 1)	BOT (n = 1)	Pap ca (n = 5)	MUO (1)
T <sub>4a</sub> N <sub>1</sub> M <sub>x</sub>	11	1	–	1	–	–	–	–	–	–	1	–
T <sub>4a</sub> N <sub>0</sub> M <sub>x</sub>	2	–	–	–	1	–	–	–	–	–	–	–
T <sub>3</sub> N <sub>1</sub> M <sub>x</sub>	8	–	–	1	–	–	1	1	–	–	2	–
T <sub>3</sub> N <sub>0</sub> M <sub>x</sub>	1	–	–	–	1	–	–	–	1	1	–	–
T <sub>2</sub> N <sub>1</sub> M <sub>x</sub>	7	–	1	–	–	1	–	–	–	–	1	–
T <sub>2</sub> N <sub>0</sub> M <sub>x</sub>	2	–	–	1	–	–	–	–	–	–	–	–
T <sub>1</sub> N <sub>1</sub> M <sub>x</sub>	0	–	–	–	1	–	–	–	–	–	1	–
T <sub>x</sub> N <sub>1</sub> M <sub>x</sub>	–	–	–	–	–	–	–	–	–	–	–	1
Total	31	1	1	3	3	1	1	1	1	1	5	1

**Table 2: Criteria for interpretation of the EMG**

Finding	Fibrillation potentials	Positive sharp waves	Amplitude (mv)	Recruitment pattern
Normal	0	0	>2	Full
Slightly abnormal	1+	1+	1.5-2	Slightly reduced
Moderately abnormal	2+	2+	1-1.5	Moderately reduced
Severely abnormal	≥3+	≥3+	<1	Severely reduced

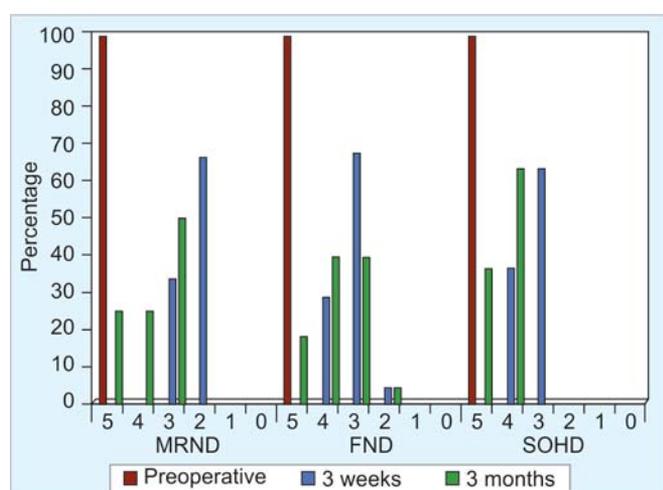
## RESULTS

Muscle strength test score were good (4) to fair (3) in all the groups in the early postoperative period.

One patient in the FND group had poor muscle strength score (2) in early postoperative period. In late postoperative period, five patients improved their muscle strength from either good (score 4) or fair (score 3) muscle strength to normal (score 5). One patient who had poor (score 2) muscle strength in the early postoperative period did not show any improvement. In the MRND group, three patients improved their muscle strength from either good or fair to normal during the late postoperative period. All the patients in SOHD group had either normal (score 5) or good (score 4) muscle strength at 3 months postoperative time (Graph 1).

Of the three groups, those patients who underwent functional neck dissection showed the most severe disturbance on EMG at 3 weeks. Of the 28 shoulders (27 patients) in this group, 11 shoulders had severely abnormal electromyogram (39.3%), 16 had moderately abnormal electromyograms (57.14%) and one had slightly abnormal electromyogram (3.6%). At 3 months, EMG showed improvement. Twelve patients (42.9%) showed normal electromyogram, 11 patients (39.3%) showed slightly abnormal electromyograms and five patients (17.9%) showed moderately abnormal electromyograms.

In the MRND group, there were 12 shoulders (12 patients). Four shoulders (33.3%) had severely abnormal electromyograms at 3 weeks postoperatively and eight (66.55%) had moderately abnormal electromyograms. In late postoperative period (3 months), one patient (8.3%) showed moderately abnormal electromyogram, six patients (50%) had slightly abnormal electromyograms and five (41.7%) showed normal electromyograms.



**Graph 1:** Distribution, expressed as percentage, of muscle strength scores by procedures obtained at preoperative, postoperative 3 weeks and 3 months

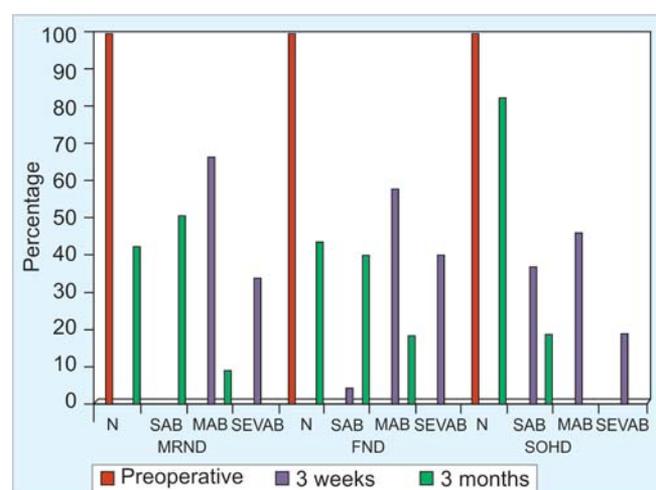
The SOHND group was found to have the least damage to the SAN as demonstrated by postoperative electromyogram. Of the 11 shoulders in this group two (18.2%) had severely abnormal electromyograms in the early postoperative period (3rd week), five (45.5%) had moderately abnormal electromyograms and four (36.4%) had slightly abnormal electromyograms. On repeat electromyograms at 3 months all showed improvement with nine patients (82%) showing normal electromyograms and two patients (18%) showing slightly abnormal electromyograms (Graph 2).

The electromyograms of the SOHND group were significantly different from both the MRND group and functional neck dissection group, 3 weeks postoperatively ( $p < 0.05$ ). The MRND group was not statistically different from the functional neck dissection group on the basis of electromyograms ( $p > 0.05$ ).

## DISCUSSION

Though there are various studies in literature comparing nerve sparing and nerve sacrificing neck dissection, there is a paucity of studies comparing different types of nerve sparing neck dissection with regard to accessory nerve function. Degree of shoulder dysfunction varies with the type of neck dissection (30%) in patients who have undergone FND compared to MRND (50%) and RND (60%).<sup>4</sup> Studies have reported that nerve sparing neck dissections were followed by a significant but temporary and reversible phase of shoulder dysfunction, whereas RND was followed by profound and permanent shoulder dysfunction.<sup>4</sup> Theoretically, nerve sparing neck dissection should result in lesser degree of shoulder morbidity.

We observed functional disturbance of the accessory nerve with all the three types of accessory nerve sparing



**Graph 2:** Distribution, expressed as percentage, of electromyographic scores by procedures obtained at preoperative, postoperative 3 weeks and 3 months; N: Normal; SAB: Slightly abnormal; MAB: Moderately abnormal; SEV AB: Severely abnormal

neck dissections. Relatively more severe nerve damage was found in functional neck dissection patients when compared with MRND patients or SOHND patients.

All patients who underwent nerve sparing neck dissections had some electromyogram abnormality in early postoperative period (most severe for FND group) which subsequently improved in late postoperative period (3 months). This could be attributed to neuropraxia resulting from traction of nerve or transient devascularization during surgery. If the SAN is not cut, this dysfunction may be reversible, but it takes a couple of months, and adhesive capsulitis may develop until its function returns to normal.

We found that SOHND has significantly better results than MRND. None of the patients who underwent a SOHND had a severe or moderate abnormality on their electromyogram at 3 months after surgery. Also there was a significant difference between the SOHND group and the MRND group at 3 weeks after surgery on the basis of their electromyogram. The difference between the SOHND group and both the MRND and functional neck dissection groups can be explained by the difference in extent of dissection in these procedures. Except for its most superior extent, supraspinal accessory region-level IIb, the posterior triangle of the neck is not disturbed by SOHND, which results in less damage to the 11th nerve. Whereas in FND, the SCM muscle has to be retracted almost until the end of the operation to expose and dissect the lymphatics along the jugular vein. This traction is even more accentuated for dissection of supraspinal accessory group of lymph nodes. In contrast, in MRND the nerve is identified and dissected free during the early stages of the procedure and separated from surrounding structures in a better exposed field with less traction achieved by transection of SCM muscle along the course of SAN.

Sobol in his study compared functional results of three types of neck dissections, namely RND, MRND and SOHND on the basis of EMG at 16 weeks and range of motion assessment of SAN function. Those patients who underwent SOHND had least damage to SAN as demonstrated by postoperative EMG. A total of 56% of patients had a normal EMG as compared to either modified radical (30%) or RND. This difference between SOHND and others was attributed to the lack of disturbance of the posterior neck during SOHND which results in less damage to the accessory nerve.<sup>3</sup> Similar to our study, literature shows that the severity of shoulder dysfunction does not always correlate closely with the degree of denervation of the trapezius muscle. In agreement with the literature, 11 patients in our FND group showed severely abnormal EMG findings in the trapezius muscle, but they did not have as great a degree of shoulder dysfunction as would be

expected. This may be accounted for by any of several factors, including the preoperative condition of other synergistic shoulder girdle muscles, patients' willingness to perform postoperative exercises, age, sex and left or right handedness.

Similarly few of our patients did not show any improvement in their muscle strength in late postoperative period while their electromyogram showed improvement. Failure of full recovery from shoulder dysfunction after neck dissection despite electrophysiological improvement was explained by Patten and Hillel as transient limitation of shoulder movement due to adhesive capsulitis secondary to neck dissections. The thickened and contracted joint capsule is strongly attached to the humeral head and sticks to it like a plaster, deserving the term 'adhesive capsulitis'.<sup>5</sup>

## CONCLUSION

SAN injuries are common in all types of nerve sparing neck dissections. The incidence of SAN injury was found to be more severe in nerve sparing neck dissections where SCM muscle was preserved (FND) compared to those where SCM muscle was sacrificed (MRND) (statistically found to be insignificant). Many of these nerve injuries improved after a period of time showing that it was only neuropraxia. Some patients who showed significant nerve injury on EMG did not have corresponding handicap clinically which was probably due to several factors including preoperative condition of other synergistic shoulder girdle muscles, patients willingness to perform postoperative exercises, age, sex and left or right handedness. Accessory nerve sparing neck dissection definitely preserves shoulder function in a large number of patients who undergo neck dissection and should be advocated in suitable cases. Aggressive physiotherapy in the postoperative period will definitely help to improve the shoulder function.

## ACKNOWLEDGMENT

We acknowledge Mr Murthy GM, neuro technologist, for his guidance in EMG.

## REFERENCES

1. Yeole BB. Trends in incidence of head and neck cancers in India. *Asian Pac J Cancer Prev* 2007;8:607-12.
2. Hislop HJ, Montgomery J. Testing the muscles of the upper extremity. In: Daniels and Worthingham's muscle testing techniques of manual examination (8th ed). India: Elsevier 2007;69-79.
3. Sobol S, Jensen C, Sawyer W, Costiloe P, Thong N. Objective comparison of physical dysfunction after neck dissection. *Am J Surg* 1985;150:503-09.
4. Salerno G, Cavaliere M, Foglia A, Pellicoro DP, Mottola G, Nardone M. The 11th nerve syndrome in functional neck dissection. *Laryngoscope* 2002;112:1299-307.

5. Köybasioglu A, Tokcaer AB, Uslu S, Ileri F, Beder L, Ozbilen S. Accessory nerve function after modified radical and lateral neck dissections. *Laryngoscope* 2000;110:73-77.

## **ABOUT THE AUTHORS**

### **Azeem Mohiyuddin (Corresponding Author)**

Professor and Head, Department of Otolaryngology and Head and Neck Surgery, Sri Devaraj URS Medical College, Kolar, Karnataka India, e-mail: azeem\_hn@yahoo.co.in

### **Sagaya Raj**

Associate Professor, Department of Otolaryngology and Head and Neck Surgery, Sri Devaraj URS Medical College, Kolar, Karnataka, India

### **Shuaib Merchant**

Fellow in Head and Neck Oncology, Department of Otolaryngology and Head and Neck Surgery, Sri Devaraj URS Medical College, Kolar Karnataka, India

### **Oomen**

Resident, Department of Otolaryngology and Head and Neck Surgery Sri Devaraj URS Medical College, Kolar, Karnataka, India

### **Philip John Kottaram**

Postgraduate Student, Department of Otolaryngology and Head and Neck Surgery, Sri Devaraj URS Medical College, Kolar Karnataka, India